REMARKS

Present Status of the Application

The Office Action rejected all presently-pending claims 1-20. Specifically, the Office Action rejected claims 1-20 under 35 U.S.C. 112, second paragraph. In addition, the Office Action rejected all claims 1, 3, 7 and 9 under 35 U.S.C. 102, as being anticipated by Harris et al. (U.S. Patent 3,824,678). The Office Action also rejected claims 2-6, 8-11, 14, 15, 17 and 18 under 35 U.S.C. 103 as being unpatentable over Harris et al. in view of Piwczyk et al. (U.S. Patent 6, 376,797). The Office Action rejected claims 12, 13, 16, 19 and 20 under 35 U.S.C. 103 as being unpatentable over Harris et al. in view of Piwczyk et al. and further in view of Usami (U.S. Patent 6,440,773). Applicant has canceled claims 2, 5, and 8, and amended claims 1, 3 and 11 above, to overcome the rejections under 35 U.S.C. 112, second paragraph. As amended, these claims clearly distinguish prior art references, and therefore overcome the rejections under 35 U.S.C. 102 and 103. After entry of the foregoing amendments, claims 1, 3-4, 6-7, and 9-20 remain pending in the present application, and reconsideration of those claims is respectfully requested.

Summary of Applicant's Invention

The Applicant's invention is directed to using the ultrashort pulse laser to cut the substrate without using a dicer or an adhesive sheet. The ultrashort pulse laser having the pulse width of less than 1 picosecond is irradiated along scribed lines between two elements for cutting substrate.

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Discussion of Office Action Rejections

The Office Action rejected claims 1-20 under 35 U.S.C. 112, second paragraph. Applicant has amended claims to overcome the rejections. Independent claim 1 has been amended to include the features recited in claim 2, in which the ultrashort pulse laser is defined as well.

Now turning to the substantial rejections, the Office Action rejected claims 1, 3, 7 and 9 under 35 U.S.C. 102, as being anticipated by Harris et al.. The Office Action also rejected claims 2-6, 8-11, 14, 15, 17 and 18 under 35 U.S.C. 103 as being unpatentable over Harris et al. in view of Piwczyk et al.. The Office Action rejected claims 12, 13, 16, 19 and 20 under 35 U.S.C. 103 as being unpatentable over Harris et al. in view of Piwczyk et al. and further in view of Usami. Applicant respectfully traverses the rejections for at least the reasons set forth below.

The present invention is directed to using the ultrashort laser to cut the substrate, in which a dicer or an adhesive sheet are thereby avoided.

With respect to amended independent claim 1, the ultrashort pulse laser having the pulse width of less than or equal to 1 picosecond is irradiated along scribed lines between two elements for cutting the substrate. Under this specific condition of the pulse width, the ***invention can at least greatly reduce the heat diffusion length (i.e. page 8, lines 7-13)*** as the unexpected results in nonobviousness. The features are recited in independent claim 1 as follows:

> 1. (Once Amended) A substrate cutting method characterized by irradiating a substrate with ultrashort pulse laser to cut it, ***wherein a pulse width of said ultrashort pulse laser is equal to or less than 1 picosecond***. (*Emphasis added*)

The features emphasized above in claim 1 are at least not disclosed by the cited prior art references.

In re Harris et al., even though Harris et al. disclose irradiating a substrate with pulse laser to cut it, Harris et al. fail to disclose the range of the pulse width. The Office Action then cites Piwczyk et al. to provide the range of the pulse width. Applicant respectfully disagree.

In re Piwczky et al., the pulse width is in the range of tens of nanoseconds or less, so that their average power level has improved (col. 3, lines 45-50). It should be noted that the quantity of *"tens nanoseconds" is larger than "picosecond" by at least 10,000 times larger.* The ultrashort pulse width laser is to have very narrow width. As a result, under the same power, the pulse height is sufficiently large, so as to cut the substrate with better effect (FIG. 5). When considering the operation mechanism, the laser with pulse width of "***tens nanoseconds***" does not disclose the ultrashort pulse width laser of the present invention by the pulse width of about 1 picosecond or less. It is not obvious to the skilled artisans to modify Harris et al. in view of Piwczyk et al..

Therefore, independent claim 1 is distinguishable over Harris et al in view of Piwczyk et al.

With respect claims 4 and 6, the features of the interpulse separation between the pulses are recited to be 3 to 30 picoseconds. This condition would also render unexpected results in nonobviousness about the phenomenon of swelling around the hole, which is lower in height (pages 18-19). This consideration of the swelling phenomenon around the hole is not considered by the prior art references, and the preferred operation condition is not disclosed either.

Therefore, dependent claims 4 and 6 further distinguish over Harris et al in combination with Piwczky et al..

In re Usami, Usami discloses that a laser beam is used to cut the wafer (claim 3). However, Usami also failed to disclose the missing features in Harris et al and Piwczky et al..

For at least the foregoing reasons, Applicant respectfully submits that independent claim 1 patently defines over the prior art references, and should be allowed. For at least the same reasons, dependent claims 3-4, 6-7 and 9-20 patently define over the prior art references as well, wherein claims 4 and 6 also recite the features further patently define over the prior art references.

CONCLUSION

For at least the foregoing reasons, it is believed that all pending claims 1, 3-4, 6-7, and 9-20 are in proper condition for allowance. If the Examiner believes that a telephone conference would expedite the examination of the above-identified patent application, the Examiner is invited to call the undersigned.

Respectfully submitted,
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VERSION WITH MARKINGS TO SHOW WHERE CHANGES MADE

In The Claims

Claims 2, 5, and 8 have been canceled without prejudice or disclaimer.

Claims 1, 3, and 11 have been amended as follows:

1. (Once Amended) A substrate cutting method characterized by irradiating a substrate with ultrashort pulse laser to cut it, wherein a pulse width of said ultrashort pulse laser is equal to or less than 1 picosecond.

3. (Once Amended) A substrate cutting method as set forth in Claim 1[or 2], characterized in that [the]a surface layer of the substrate[which is in an improved state] is irradiated with said laser.

11. (Once Amended) A substrate cutting method as set forth in Claim 10, characterized in that the thickness of said semiconductor wafer is [not more]equal to or less than 50 μm.